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THE

CHINOOK WINDS

—AND OTHER—

Climatic Conditions of the North-West,

—BY—

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—AND—

OTHER CLIMATIC CONDITIONS OF THE NORTH-WEST.

Some one has said "The climate makes the country". If this proposition is only measurably true—and there seems no doubt of it—there are few questions of greater importance in connection with capacities and future prospects of our land. It may have been noticed how readily the citizens of our country, having grown proud of the country, become likewise proud of the climate. If climate were a matter of latitude merely, and zones of temperature coincided with the parallels, the question would be as simple as the matter of day and night, the advancing sun giving summer, and the declining sun, winter. But searching into the matter of a difference of temperature in the same latitude, we become aware of the fact that summer has its cold and winter its heat in various localities, in a way not at all in accordance with latitude or season. For instance spring opens about the same time at Fargo, Winnipeg, Battleford, and Peace River. So the matter is more complex, and without committing ourselves to a search after storms or local disturbances we have a wide field for investigation. It would be counted a strange method to open up the question of our climate with a consideration of a phenomenen occurring 1,000 miles west, but our ideas readily adapt themselves to the largeness of our land. "No pent-up Utica contracts our powers, but the whole boundless continent is ours," and we easily regard the Rockies as only just the other side of our horizon. Moreover, it will appear on enquiry that the Chinook Winds are intimately connected with the whole question of our climate. These winds are noticed by the observer as coming down in the depth of winter from the snow-covered mountains so warm and dry as to cause the total disappearance of the snow in a few hours. Most striking along the mountains near Calgary, yet some effect has been noticed as far east as the boundary of Manitoba, and even as far as the Arctic Circle, there are days of decided thawing in the month of January. (The Chinook Winds are so called from the tribe of Indians of that name in British Columbia.) So hard is it to credit the evidence of our senses that the common description of these winds is that they come through the passes of the mountains, from the Pacific—a wonder none the less than that which it is supposed to explain. One observer of some note, indeed, hazards the conjecture that the warm winds of the Gulf of Mexico reach all the way up north, over the high plateau of the great American desert, over the still higher mass of hot and rarified air overhanging this desert, and drop conveniently on our lower plains to the north. But as this writer—of deserved repute in his own department—manifestly confounds the lines of equal heat with the direction of the winds, we may be excused from giving much consideration to his theory. Fortunately, we have sufficient data of a strictly reasonable and scientific kind, without indulging in conjectures which, too often, are the only support of theories on climate or the weather.

A very brief statement of a few points in physical geography may be necessary as a prelude to the consideration of the matter before us.

Joseph Cook, of Boston, said a few days ago that the first question he would ask a class in physical geography would be the following: Suppose the earth were to turn the other way on its axis, what would be the effect on the climate of North America? Not altogether an insoluble conundrum, perhaps, with a little thinking. As it is some time perhaps since most of us have been at school, we may rehearse a short lesson on the Trade winds. Heated air at the Equator rises and is replaced by a rush from the North and South. As this air comes from a part of earth having slower motion, the earth turning towards the

East leaves the air behind and causes thus a N.E. wind, north of the Equator, and a S.E. wind south of the Equator. These winds blow steadily and are known as the Trade Winds. (It is well to bear in mind just here that, with evident modifications, from the shape of the continents, the ocean currents are governed by the same laws.) Outside of the region of trade winds, i. e., from 30° to 60° north lat. is a zone noted for its alternate winds; winds from the southwest alternately with winds from the northeast —the southwest prevailing. This is the belt of the Return Trades, or Anti-Trades. As the trade winds get their direction from the motion of the earth, which glides, as it were, from under the cool winds moving equator-wards—so the anti-trades passing northwards retain the westward motion gained at the equator, and in latitudes not so progressive they outstrip the motion of the earth and thus give rise to southwest winds. But these have not the persistency of the genuine trades of the equatorial regions, and so merely alternate with the polar winds from the northeast.

Such being the state of things in the wide belt including such a great part of the continent, we may now take up the local modifying influences. Consulting our map, we notice a lofty barrier along the west coast—in fact a number of successive ranges of mountains. The point most interesting to us is where the coast range is broken by the inlet called the Straits of San Juan. And here let me call attention to the peculiar elbow made by the ranges nearest the ocean, the direction changing from due north to northwest—best seen on a globe. Next note that all the ranges are much lower here than further south. The coast range south of 49 rises up like a great wall, and the inner ranges are still loftier. North of 49° the mountains decline, except some peaks, till in Alaska they become quite low. The number of passes too and their low elevation were long remarked in view of the prospect of a railway through Canada. Then the valleys of the Fraser and Columbia give unmistakeable hints of passages through the mountains, which furnished a pathway for the winds long ages before the adventurous railroad builder threaded his way across and through the labyrinth. The southwest winds then, blowing warm from the Japan Current, the Gulf Stream of the Pacific, brought to a focus, as it were, in this angle of the mountains, crowd onward through the river valleys, over the lower ranges, across the sea of mountains of British Columbia, and finally breasting the last great wall of the Rocky Mountains, make their final leap down into the plains below.

Having thus traced their course over the mountains, let us inquire into their adventures in this journey of 500 miles.

On leaving the Pacific they are warm and heavily laden with moisture. The first range they meet takes toll from their burden. Heavy clouds are formed and rain falls. The process is repeated at each successive range. In higher regions the scanty supply of moisture now becomes snow. In lofty altitudes, almost completely robbed of moisture, they become greatly rarified and very cold.* Moisture is gone and heat is gone. Our problem is still unsolved.

Let us now retrace our steps to the coast, and examine into the question of heat, for modern science declares that that is never lost any more than any other force of Nature. We find that in each condensation, first cloud, then rain and snow, heat is produced—to speak accurately, latent heat becomes sensible. Rain and snow remain behind, are lost absolutely to the air currents. Not so the heat: this remains with the air, and seems to be increased. But in the lofty regions of the Mountains rarefaction takes place, and this uses up heat. It requires heat to produce rarefaction, or disappearance of heat accompanies rarefaction, put it which way you will, the heat is not lost, and when, pouring down the mountain side, the great volume of dry air becomes condensed again in lower altitudes, this heat, latent away up in the lofty peaks, now comes out from its hiding-place, and the dry and warm air proceeds to business by licking up the snow, not leaving behind even the moisture caused by its melting. We are speaking now of the winter. Not much heat can be lost in contact with the dry snow, and what is lost by radiation into space may be made

* In spite of the great cold of the lofty range of the Rocky Mountains proper, the snow line is much higher than in the coast ranges, and glaciers are comparatively rare, the simple reason being that the moisture of the air is exhausted on the first range and there is not sufficient snow to form glaciers. This difference in the height of the snow line in the Sierra Nevadas and Rockies in the same latitude amounts to 3,500 feet.

up by the heat of the sun even in the short days of winter. This in brief is the explanation of the Chinook winds.

Some other considerations remain to be noticed. The time, as I have just said, is winter. In the long melting days of early summer, over the dissolving snows of the ravines and warm slopes, over thousands of foaming torrents and countless rivulets, the air instead of gaining heat now loses it by the reverse operations of liquefaction and evaporation and thus chilled it drops on the ill-fated potato patch in the form of June frost.

This matter of heat being absorbed by thawing and set free by freezing is one of common observation. The chilly feeling of a March or April day is shiveringly in the memory of all of us who in early life braved the inclement skies of Ontario. And some of us have known the farmer's plan of saving his potatoes by carrying water into the cellar on an extra cold night—the water giving off in the process of freezing, heat sufficient to save the vegetables. Of course the process does not go on ad infinitum. But the process of heat disappearing by the rarefaction of air and becoming sensible again on re-condensing—this is not so much within the range of our daily experience. The falling of the barometer before a storm is due to rarefaction of the air, and we have all noted the increasing coolness at such a time, though almost invariably this is accompanied by the formation of clouds which quickly shut out our great source of heat, the sun, so that the lesser cause of coolness is obscured by the greater. Those who have ascended mountain peaks have observed (1) the rarity of the air and (2) the coolness. They may now consider if the latter is caused by the former as post hoc is not always propter hoc.

Suppose they are not related as cause and effect, but only accidentally. Then, first, why is it it warmer near the sea-level? It cannot be the earth simply which gives the heat, for then, a high plain, or even a mountain peak, might be as hot as the low level, and second, we know that heated air rises, so the higher the elevation the warmer should be the air. The fact is, nature does not work for nothing, or with nothing. If a gas, air for example, becomes rarified—and it will if it gets a chance—heat is used up in the process. And when the re-condensing takes place the heat is given off again, all of it. Nature is not a banker and knows nothing of discount. When a spring is compressed, its power lies dormant. You wind up your watch, you are only storing up the force exerted by the muscles of your fingers, and the spring will give back all the force again, minus the friction, of course. I have dwelt at some length on this point because it is one in which the greatest incredulity is manifested, and all sorts of theories have been projected from the refusal to believe that warm winds can come from snow-clad mountains.

When Sir Alexander MacKenzie first wintered on the Peace River, away up in lat. 56°, like a second Balboa, looking out in his mind's eye over the great Pacific, he saw the striking effect of these south-west winds and noted in his journal that the ocean could not be far away. Little did he think that nearly 600 miles of rough mountain lay between him and its warm shores. This was in 1792. He remarked the difference between the effect there at the mouth of Smoky River, where the snow disappeared in a few hours, and at Fort Chipewyan on Lake Athabasca, 300 miles further east, where no thaw occurred, though the wind brought delightful clear weather.

It is only a few years since one of those indefatigable slaves of nature, a German doctor—what should we know but for the German doctors?—worked out a mathematical demonstration of the amount of heat made latent by rarefaction in the higher altitudes and regained by condensation; and, still more, the amount of heat caused by the precipitation of moisture as the wind rises up the slope of the mountain. This calculation, I may say, seems to have been undertaken to solve the same problem in Europe, for they have, it seems, chinook winds under the lee of the Alps and the mountains of Norway, only chinook is not the German name of it. It is said that even the west coast of Greenland is visited by such a wind coming over the elevated land of the interior.

Not to pursue the somewhat wearisome details, we may briefly outline the calculation. The estimated heat lost in the ascent of the mountain slope by rarefaction is 1° C. for each 100 metres of elevation, and 1° of course is regained in falling. But as we have seen that considerable heat is given off by the condensation of vapor to rain and snow, this loss of 1° is reduced to ½° C.

per 100 metres—or translating into our own less civilized scale of measurement, 1° F. equal 5-9° C.; and calling the metre 39 inches, we have 1° F. lost for each 345 feet. Now, supposing an altitude of 6,900 feet for the main range of the Rockies (a slight exaggeration), we have a loss of 20° of heat. But in descending the mountains again 1° F. is gained for each 172 feet of fall. Taking Calgary at 4,000 feet in altitude, there is a descent of 2,900 feet, equivalent to a gain of 17° F. nearly. In the Peace River country the result is more striking, as the height is only 2,300 feet, and therefore the fall is much greater. The mean winter temperature of the Pacific for a wide zone off the coast of North America is given at 56° F. The problem is simply 56° less 20°, plus 17—a net loss of 3°, leaving 53° as the heat of our chinook winds in the region of Calgary. [I am sorry not to have had the privilege of access to any statistics of observations in the locality of Calgary. With more time for correspondence I hope to be able to compare my figure with the results of observations.] In this estimate we are not bound to take the mean winter temperature of the ocean, but rather we should take the temperature of winds with sufficient force to carry them over 500 miles of Mountain ranges. These winds come from the southwest far away over the ocean, and not cooled by the colder current along the coast inside of the Japan Current.

We have constantly to remember the looseness that prevails in our ideas of heat and cold. Two quite different standards prevail, one the thermometer, the other our feelings. In summer 40° F. is quite too near the freezing point to be pleasant, while as we all know anything near zero in the winter is bracing and delightful. But water freezes and snow melts, not by our feelings but by the thermometer. 35° F. with dry air is quite sufficient to remove six inches of new-fallen snow. And we must not think of these winds as constant. They alternate with their contending brothers from the north, this belt of alternate winds extending around the whole globe.

In the somewhat limited range of my search there is no part of the globe regarding which statistics of winds are so meagre as in the region under consideration. Yet the conditions are evident, and now that the facts are becoming known, the correspondence between them is not wonderful.

The fact is simply this: The great fertile belt lies just on the border where the polar winds, somewhat moist and decidedly cold, meet and contend with the heated air from the Pacific, dried but only partially cooled by the mountain ranges it has crossed. This contact of heat and cold in the air always produces precipitation, rain or snow. The Arctic Sea and Hudson's Bay, a cold region, do not give so much moisture as the warm currents of the Pacific. (Hot air holds more vapor than cold.) Hence we have little rain or snow, decreasing from N. E. to S. W. till in the high dry barren desert country south of 49° the supply is exhausted. In fact the so-called Great Desert is in a sense outside of the region of precipitation. It is too far from the Arctic and Hudson's Bay to get either rain or snow, which have been evenly distributed over the intervening country, there being no mountain range to intercept the clouds. It is too far from the Pacific, for south of latitude 45° the mountains are very much wider and higher, forming a barrier to any possible clouds, moreover the plateau itself is very elevated—almost out of the way of any respectable cloud region. Finally, it is out of the way of the Gulf winds, which have quite enough to do to water the Southern and Central States, and lose all their moisture long before they reach this lofty citadel of barrenness. For all that I am far from saying that this same region does not exercise a great influence on the climate of our western plains. A south wind blowing from these elevated plains would largely partake of the nature of the Chinook winds, dry and warm for very much the same reasons and with the same effect. But here in Winnipeg we know that a wind from the south in January has to blow for several days before it produces much effect in the thermometer.

Returning again to our Fertile Belt, it may not be superfluous to call attention to the fact that the same cause which now keeps up the fertility of the Great North West, evidently produced that fertility.—Even in remote ages—geological ages—there must have prevailed the same climatic conditions, the same warm Pacific winds, dry to a degree probably forbidding forest growth, the same colder and damper winds from the north, the same mantle of snow and same deep grip of winter's frost to modify the too ardent flame of

our long summer's day, which would otherwise parch the tender shoots of growing plants. These conditions must have prevailed since the northern half of the continent has had the shape it now has.

We may now venture on an answer to Joseph Cook. Since the prevailing winds and currents of the ocean are caused mainly by the rotation of the earth, in conjunction with the tendency of all fluids to seek the warm region at the equator, as we have seen, it is manifest that a reversal of the direction of the earth would cause a corresponding reversal of the winds and currents. The great Equatorical Current which now sets westward with a northward deflection by the coast of South America would then go to the East and turning North from Cape Verde would skirt the shores of Spain and France, or more likely would strike away to the North West along the edges of the Arctic Current, which would come down with its Greenland and Norwegian icebergs around the bleak and barren shores of England and Ireland. Newfoundland would usurp the climate of the Emerald Isle, the fogs and codfish and bluenoses would be on the other side of the Atlantic, and the warm Eastern breezes from the Gulf Stream (rather now the Biscay Current) would sweep across Quebec and Ontario and Labrador. On the western side of the Continent, the change would be the same in nature but very much less in degree. For the Pacific would still be independent of Arctic Currents and Japan could exchange places with Vancouver without so great a disturbance as we have seen in the case of the Atlantic.

In our own country, the Fertile Belt would run from N. E. to S. W. The warm breezes from the Atlantic would be felt in some degree, mainly in tempering the cold blasts of Boreas, but in the main our climate would not be improved. But all over the world elsewhere the change would be so great that we might almost say that America would have been discovered from the Pacific. England would have been civilized from Japan and China. The Irish Question would have been settled on the Gulf of St. Lawrence, and Joseph Cook, of Boston, would have discoursed of light and sweetness on the sand lots of San Francisco—leaving his brother apostle Matthew Arnold to promulgate a return to orthodoxy in the progressive islands of Japan.

"Eastward, the Star of Empire holds its way" with this new order of things.

In conclusion, a brief reference to the geological conditions of our climate and soil. And in this matter I shall venture only a few conjectures.

It is well known that the Laurentian Range and the Rocky Mountains did not always hold their present relations. The Alleghanies give evidence of some astonishing upheavals and alternate depressions. It is more than probable that this range once presented plateaus and peaks compared to which the present Himalayas would be mere dwarfs. With this range, however, we have nothing to do. But similar convulsions of the crust of the earth are equally well evidenced in the case of the mountains in the west and north of the Continent. If observations in the geological ages from a neighbouring planet could be imagined, the records of some lunar or Martian patriarch would indicate the startling changes of the mighty ridges of the north and west.

The old frame work of our continent, the very first to appear above the archaic waters, has now sunk so low that we are apt to forget the part it played in the formation of our country.

Once the Rockies were too low to obstruct the moisture-laden winds, which thus swept far inland across the plains; the Laurentian range, the true and ancient backbone of the Continent, then reared its lofty head higher than even the Rocky Mountain range, its younger upstart brother, catching the moisture carried all the way from the Pacific and condensing it in the form of great snow masses and glaciers, while at the same time, on its northern slope was gathering the icy breath of the Arctic Sea. This was a glacial crest, if not identical with, at least similar to, the great Polar ice-cap of geological times.

To compensate for this sinking process along the line of the Laurentian, the slopes of the Rockies begin to assume the proportion of mountains. Higher and higher the various ridges continue to grow till at last the damp winds, no longer able to carry their burdens over the lofty peaks drop them on the western slopes to find their way back to the Pacific.

Such a state of things furnishes a solution of some of our problems. Mighty glaciers have written their autobiography in marks and deep grooves over the rocks of half our continent, a record before which

the works of Memphian kings are as insignificant as they were when compared with Milton's satanic architects. These glaciers sliding down to the south and west would scarcely yield to anything but the periodical visits of great Sol himself, the drippings furnishing a supply of pure ice water for the Mississippi. Their grinding action made the soil; and the streams and fogs and rains along its borders furnished moisture for the coarse and hardy vegetation of the times. But what the sun, unaided, could not accomplish in the the lofty rarified air of these primitive peaks, was at last accomplished by the subsidence of the great range itself. Back, slowly back, through successive centuries the glaciers retreated; leaving a great shallow lake between the rear of their baffled columns and the newly elevated coasts whence the shortened Mississippi took its rise. Still further centuries and a further subsidence drained off even the most of this lake, a mere sluggish and tortuous creek serving to mark the deepest part of the old lake—the present Red River of the north. This immense uplifting of the Rockies effectually shut off the supply of moisture from the Pacific and thence forward came the present climate of our Northwest.